Comparative Analysis of Bioenergy Markets' Traits and Policies in Japan and Ukraine

Kagatsume, Masaru; Trypolska, Galyna

Comparative Analysis of Bioenergy Markets' Traits and Policies in Japan and Ukraine

Masaru Kagatsume and Galyna Trypolska[1)]

加賀爪　優、ガリナ トリポルスカ「日本とウクライナにおけるバイオ・エネルギー市場の特徴とその政策に関する比較分析」

本稿の目的は、日本とウクライナにおけるバイオ燃料市場における政策の差異を比較・検討することである。利用可能な資源量、バイオマスのポテンシャル、バイオ燃料需要の主要な規定要因、バイオ燃料を生産するための制度と技術の観点から論じる。その帰結は以下のようである。すなわち、ウクライナのエネルギー部門には日本よりもマーケット・メカニズムが導入されている。ウクライナは、土地面積も広く飼料作物も豊富であり、バイオ・エネルギー市場を開発するための制度や財政的インセンティブが発展している。他方、日本のエネルギー部門は、より政策誘導的であり、既存のバイオ・エネルギー市場を推進するための事業にとってより有利な経済環境に依存している。

両国の場合において共に、なお一層の制度の改善と整備が必要とされている。ウクライナに関しては、燃料混合規制が絶対に必要である。他方、日本に関しては、バイオマス利用の目標水準を達成するためには、ガソリンおよび他の燃料の品質規制およびそれに関連する課税制度に関する法律の修正が必要である。本稿の分析により、以下の点が指摘される。より広い意味において、バイオ・エネルギー市場の推進と開発のためには、一般的な傾向として、より環境へ配慮することと同時に、両国に関して、効率的で適切なエネルギー政策を行うことが、基本的に必要不可欠である。

1. Literature review

For better understanding of the possible role of bioenergy sector in Japan, a Japanese energy sector was reviewed at Takase et al [2)]. The authors provided not only the review of the energy sector itself, but also the existing policies that regulate the market, as well as possibilities of GHG reduction.

Prospects for Japan to produce biofuels in relation to country's meeting of Kyoto targets are stated in Fukuda et al [3)]. The analysis of biomass utilization scales, as well as utilization of each biomass type is stated by Matsumura and Yokoyama [4)]. Woody biomass supply potential for thermal power plants in Japan was studied by Kinoshita et al [5)]. Authors performed an economic evaluation of forestry using a grid mesh covering Japan and concluded that the country has a significant potential of forestry to use wood chips at coal powered thermal power plants. A very detailed count of all possible biomass resources in Japan was conducted by Saka et al [6)]. Prospects of biomass utilization in Japan, as well as its projections till 2050 are measured by Yoshioka et al [7)]. A comparative study on the energy policies in Japan and Malaysia in fulfilling their nations' obligations towards the Kyoto Protocol was conducted by Lee at al [8]. Finally, the most relevant factor for this study was a paper by Matsumoto et al on biofuel initiatives in Japan [9].

Possibilities of the agricultural sector of Ukraine in terms of its energy self-supply were considered by V.Mesel-Veselyak [10]. Energy potential of forest residues in Ukraine was provided by the Institute of Renewable Energy, UAS [11] and [12]. Energy potential of biomass for liquid fuel production was provided by G.Zabarnyy at al [13]. Energy potential of new energy crops was considered in M.Pugovytsya [14][15], D.Rakhmetov [16] and L.Futerko [17]. Biomass energy potential in Ukraine, as well as some recommendations on the ways to increase possibilities of biomass utilization, were described in Biomass action plan for Ukraine [18]. Information and the statistical data base of research was obtained from Ukraine Energy Policy Review, World Energy Outlook 2009 (IEA), FAPRI, Toepfer Intl, State Committee of Statistics of Ukraine.

As we may see from the literature analysis, a majority of papers are dedicated to the assessment of biomass use potential. This is true both for Ukraine and Japan. These data are absolutely important stating the "ceiling" for bioenergy sector development; nonetheless much less attention is paid to the issue of bioenergy market regulation. Understanding the tools and the economic mechanisms of its development may promote further use of biomass and a widening of this market. Comparison of efforts of both Japan and Ukraine in the creation and regulation of the market with focus on efforts in Japan, may provide an insight of the tools for a more efficient bioenergy market development in Ukraine. Also, it is interesting to see how Ukraine can adopt best practices of market regulation from Japan, and vice versa.

2. Resource availability and biomass potentials

Japan is one of the word's most developed and industrialized countries, where oil and coal are two major types of energy carriers, fueling industry's and household s' energy needs. Ukraine has got its status as a country with market economy in 2006, being one as the most energy intensive economies in the world, where imported natural gas is an unambiguous leader in the energy supply structure (Table 1). Both Japan and Ukraine rely heavily on imported energy carriers, thus deployment of domestic renewable sources of energy, such as biomass, may provide a chance of a slight decrease of this dependency.

Table 1　Structure of Primary Energy Supply, %

Energy source	Japan (2007)	Ukraine (2004)[19]
Natural gas	16	47
Oil	47	12.4
Coal	21	22.5
Nuclear	10	16.2
Renewables	**3**	**0.9**
Hydro	3	1

Sources: IEA, Ukraine Energy Policy Review, 2006, pp. 75-77 ; The Japanese energy sector: Current situation, and future paths. Kae Takase, Tatsujiro Suzuki. Energy policy (2010).

Both countries have completely different geographical and climatic conditions, soils, arable land amounts and biomass resource potentials. Japan imports 60% of food consumed [20], which emerges from the fact this country has very limited arable land, which decreases possibilities of bioenergy use in Japan, unless bioenergy is produced from any kind of residues. It is worthy to mention that Japanese industry shows itself in a very inventive way, using all possible kinds of feedstock available, for instance, waste cooking oil is a source of biodiesel in Japan. The potential and availability of biomass for bioenergy utilization in Japan was thoroughly summarized by Saka et al [21].

As shown in Table 2, total biomass and residues mass, available for bioenergy use purposes, is more than 76 mln t a year, which translates into 125 mln t of CO_2. This amount corresponds to 11% of carbon dioxide emitted in Japan in 1990. Also, as we may see it from the Table 2, the most prospectus resources of bioenergy in Japan are non-industrial residues, followed by wood and agricultural residues, whereas planting of dedicated energy agricultural crops is barely possible in of land shortage conditions. Another assessment of bioenergy potential in Japan (as of 2004) is provided in Table 3.

As shown in Table3, unutilized forest and dedicated energy crops have the largest bioenergy potential, which provides results slightly different to those of Table 2 regarding the dedicated energy crops.

Ukraine, to the contrary, has significant amounts of biomass and biogas feedstock, due to its large areas of arable land, as well as all kinds of residues. Several assessments were made for different types of biomass sources (Tables 4, 5).

Total possible saving of fossil fuel through use of liquid biofuels is provided in table 5.

Energy potential of vegetable agricultural biomass, that is available for use to obtain heat and electricity, is even higher, as it includes all kinds of forest residues, straw, sunflower

Table 2 Structure of Primary Energy Supply, %

Resource	Mass available
Virgin resources (Sugar, sugar cane, sugar beet, starch, rice, wheat, potato, sweet potato, taro/yams, maize for silage)	0
Forest resources (Wood, sasa, bamboo)	29.768
Oil/fat crops (rapeseed, groundnuts, soybean)	0
Others (pasture grasses, fruits, vegetables, other crops)	0
Wood residues (leftover branches, wood from thinning, factory residues, construction residues, waste paper)	9.78
Agricultural residues (rice straw, rice hull, wheat straw, bagasse, other a/g residues)	8.629
Livestock residues (hull, carcass)	0.7
Residues from fishery	8.52
Industrial residues (pulp sludge, waste oil/fat, animal residues)	2.13
Non-industrial residues (municipal refuse, sewage sludge)	16.66
Total	**76.187**

Source: Biomass resources present in Japan-annual quantities grown, unused and wasted, E. Minami, S.Saka / Biomass and Bioenergy 29 (2005) 310-320

Table 3 Biomass potential in Japan

Feedstock	**Potential**, ths kloe [22)]	**Potential**, ths ktoe
Unutilized forest	3200	2758.621
Dedicated energy cops	850	732.758
Non-food parts of A/g crops	620	534.4828
Wood waste from construction	600	517.2414
Wood waste from forest	510	439.6552
Wood from thinning	490	422.4138
Wood waste at the factory	250	215.5173
Molasses	10	8.6207
Total	**6530**	**5629.3106**

Source: Japan Country Report. APEC BIOFUELS TASK FORCE October 7-9, 2008 www.biofuels.apec.org/pdfs/apec_200810_ikeda.pdf

husk, cane, specially planted new energy crops such as rumex hybrids, etc. In Ukraine, about 20 mln t of straw are burned on the fields annually, as the straw is not used. Based on assessment of available types of straw (derived from wheat, soy, sunflower, rapeseed, corn) for burning to obtain heat, it is reasonable to use about 41.1 mln t of straw in 2010 and 69.5 mln t in 2020. This assessment includes use of straw on the fields, for feed and for other farming purposes, thus the amounts mentioned are realistic and do not cause any harm to

Table 4　Energy potential for bioethanol productiozn from various types of feedstock in Ukraine, *mln t/year*

Feedstock	Amount, *mln t/year*
Sugar beet	0.55202
Maize	0.65854
Potato	0.27681
Total	**1.48737**

Source: Zabarnyy G., Kudrya S., Kondratyuk A., Chetverin G.. Thermodynamic efficiency and resources of liquid biofuels of Ukraine. –Kiev: Institute of renewable energy, UAS, 2006. – 226 p. (in ukr.)

Table 5　Possible savings of fossil fuel through use of biomass

Type of fuel	**Saving of fossil fuel,**	**Saved coal equivalent fuel, *ths tce/year***	**Saved oil equivalent fuel, *ths tce/year***
Ethanol	**Saved petroleum, *ths tce/year***		
From sugar　beet	330.34	510.68	357.476
From corn	394.2	611.4	427.98
From potato	165.6	256.95	179.865
Subtotal	*890.14*	*1379.03*	*965.321*
Biodiesel/vegetable oil	**Saved diesel fuel, *ths t/ year***		
Rapeseed oil	111.44	157.54	110.278
Rapeseed biodiesel	2014.38	2846.1	1992.27
Sunflower seed biodiesel	187.92	265.22	185.654
Soybean biodiesel	325.36	459.69	321.783
Subtotal	*2639.1*	*3728.55*	*2609.985*
Total		**5107.58**	**3575.306**

Source: Zabarnyy G., Kudrya S., Kondratyuk A., Chetverin G., Thermodynamic efficiency and resources of liquid biofuels of Ukraine. –Kiev: Institute of renewable energy, UAS, 2006. – 226 p. (in ukr.)

agriculture. Use of straw for energy purposes would allow saving of 16.8 and 27.8 bln m^3 of natural gas in 2010 and 2020 respectively [23].

According to assessments of SEC “Biomass” and Ukrainian-Dutch intergovernmental project, use of biomass may satisfy about 13% of country's needs in primary energy [24] (Table 6).

Several R&D projects are in progress to breed new energy crops varieties and hybrids suitable for various types of soil and climatic conditions; these projects are taken on by JSC “RIKA-Biopalyvo”, national botanic garden named after Gryshko, National Agrarian University, etc. Examples of new energy crops are mallow, sida, siplhium, earthnut, safflower

Table 6　Energy potential of different sources of biomass in Ukraine, *mln toe*

Source	Technical potential	Economic potential
Cereal crops straw	15.127	0.938
Rapeseed straw	0.525	0.525
Maize stalks, leaves, cobs	2.793	1.953
Sunflower stalks, корзинка, husk	2.002	2.002
Wood	1.162	1.036
Energy crops (willow, poplar, miscanthus, alder tree, acacia)	8.673	8.673
Total	**18.802**	**15.127**

Source: Biomass action plan for Ukraine. 2009. – Kyiv. – 44 p. Ministry of agricultural policy and Agency SenterNovem of Ministry of economics of the Netherlands. (in ukr.)

and bunias. Rumex hybrid, for example, is highly resistant to unfavorable environment conditions, gives 3 harvests a year with an average yield of 15 t/ha of dry matter, and it is already used as an energy crop in Check Republic and China [25)]. In 2007 this Rumex hybrid was registered as an energy crop in the EU; in China it is planted in mountain regions and abandoned lands [26)]. Another highly potential energy crop is sida, harvested area of 80-100 ha of which are sufficient to provide heat to 100 households. Sida and silphium each can provide up to 25 t/ha of dry matter and can grow in one place within 20 years. Miscanthus is also planted in Ukraine, the first yield of which (200 t) is expected in 2010, will be used for heat. Overall, new energy crops may productively grow and provide from 6 to 20 tons of dry matter (Fig.1), 12-15 t/ha of liquid biofuels with calorific value of 3400-4500 kcal/nm^3 [27)] .

According to the assessments of the Institute of Renewable Energy, UAS, energy potential of forest residues is 5.247 mln^3 or 861.6 ths tce annually [28)]. Annual timber procurement in Ukraine (15 mln m^3), provides 12% of this amount as slash, 35% as edging, 31% of residues of furniture production and 31% of residues of furniture production and housing construction [29)]. In 2009, about 1200 boiler houses were operating on an industrial wood residue forest sector of Ukraine. During the same year, the State Forestry Committee of Ukraine suggested to the Cabinet of Minister of Ukraine to develop a State Program for using the resource potential of wood, but that Program was never developed due to lack of corresponding lobby [30)].

Due to available agricultural lands and cattle breeding Ukraine has a possibility to develop its own biogas market. Variety of feedstock for biogas production is really big – distillers grains with soluble, plants residues, animal dung etc (Table 7). Respectively, main “producers” of biogas should be sugar refineries, farms, meat-processing plants, breweries and other processing enterprises. Biogas can be used both for the needs of these enterprises and to replace natural gas in public utilities. Ukraine has 29.965 ths boiler houses, 64.3% of which

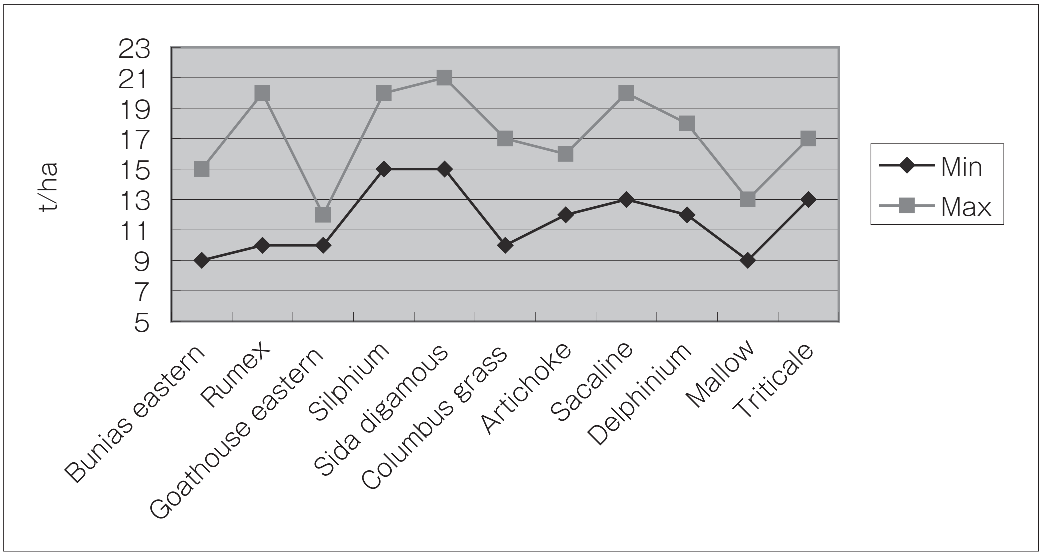

Fig.1 Output of dry matter of new energy crops, *t/ha*

Source: S.Kalenska, D.Rakhmetov Justification of alternative sources of plant material for biofuel production. National Agrarian University, National botanic garden named after N.N. Gryshko. 2008. (in ukr.)

use natural gas. In 2008, to produce heat for households, 8 bln 369 mln m^3 of natural gas was used.

Energy value of 1 m^3 of natural gas equals to 1.75 m^3 of biogas. According to different estimations, economic potential of biogas in Ukraine without landfill gas is 1.8-1.96 mln t c.e./year (Table 7).

As we may see, Ukraine has sufficient energy potential of all kinds of biomass to replace up to 15% of its energy needs. Utilization of this potential strongly depends on level of economic activity, as well as on proper legislation and policies.

Japan and Ukraine has different feedstock for biofuels production. Japan has limited agricultural lands, as well as abandoned agricultural lands – 9.7%, looking for taking the most of land and resource available. Thus, the country is especially interested in the promotion and commercializing of 2nd generation biofuels, which would decrease the need in land and avoid competition for food. Ukraine has plenty of available agricultural land, having a possibility to produce designated bioenergy crops even those of the 1st generation. Japan already has not only the technologies but also several pilot projects to produce 2nd generation biofuels. In Ukraine, efforts are mainly concentrated on market spread of 1st generation biofuels, nonetheless certain research is conducted to study 2nd generation biofuels technologies. Much bigger focus on 1st generation technologies will lead to the fact that these technologies are slowly but persistently becoming outdated, and the whole production

Table 7　Energy potential of different sources of biomass in Ukraine, *mln toe*

Type	Theoretical potential, mln t o e	Technical potential, mln t o e.	Economic potential, mln t o e
Biogas from dung	2.89	1.715	0.532
Biogas from sewage water	0.147	0.091	0.063
Biogas from corn	1.113	0.777	0.777
Total	**3.549**	**2.583**	**1.372**

Source: State of art and prospects of biogas production in Ukraine. Ministry of agricultural policy. 2009 http://www.minagro.kiev.ua/page/?n=7793 (in ukr.)

technology is extensive (for example, highly energy intensive). But both countries need to improve their technologies of collection, cutting and transportation of feedstock for 2nd generation biofuels.

As for 1st generation biofuel technologies, Japan does not have a specific feedstock, readily available on a large scale, except for biodiesel, where one of the specific feedstock is canola/rapeseed. In the case of Ukraine, the country does have specific available feedstock, such as wheat, corn, molasses for ethanol production. One of the reasons to have these types of feedstock is to protect agricultural producers from unfavorable conditions of external wheat/corn markets, i.e. when their prices are too low. Production cost of 1st generation bioethanol varies, being approximately similar in both countries: 0.98-1.24 $/l in Japan and about 1 $/l in Japan. The reasons are high feedstock prices, as well as high energy intensity of production process in Ukraine. Ukraine tends to produce biofuels from dedicated feedstock and not from wastes, which provides higher chance for biofuels to emerge in the market, but at the same time it carries some threats, such as vulnerability to market conditions. This is especially the case with rapeseed, 90% of which is exported to the EU to satisfy the demand of their biofuels industry. The only tiny exception is intension to produce biofuels from sugar refinery wastes. In Japan's case, the country does try to use all possible wastes.

International Energy Agency (IEA) anticipates increased use of biomass and wastes in the world's energy carrier mix, as deposits of fossil energy sources steadily decrease, technologies of biomass utilization become more mature and commercialized, and with technological development countries' energy demand doesn't decrease (Table 8):

Table 8　World primary energy demand by fuel, *mln toe*

Fuel	2000	2007	2015	2030	2007-2030
Oil	3655	4093	4234	5009	0.9%
Coal	2292	3184	3828	4887	1.9%
Gas	2085	2512	2801	3561	1.5%
Biomass and wastes (traditional and modern use)	**1031**	**1176**	**1338**	**1604**	**1.4%**
Nuclear	676	709	810	956	1.3%
Hydro	225	265	317	402	1.8%
Other renewables	55	74	160	370	7.3%
Total	**10018**	**12013**	**13488**	**16790**	**1.5%**

Source: World Energy Outlook 2009, p.74.

As shown in Table 8, ratio of biomass increase use was far outpaced by "other renewables" growth, nonetheless both in 2015 and 2030 IEA expects bioenergy and wastes utilization to become the fourth energy carrier in the world primary energy mix. A closer look at the table and some trivial calculations brings us to the conclusion that share of biomass in primary energy demand will be slightly decreasing, as the whole primary energy demand increases 1.5% in 2030 relative to 2007. But the share of oil and nuclear energy will also decrease.

Table 9　Share of different types of fuels in world's primary energy demand, %

Fuel	2000	2007	2015	2030
Oil	36.5	34.1	31.4	29.8
Coal	22.9	26.5	28.4	29.1
Gas	20.8	20.9	20.8	21.2
Biomass and wastes (traditional and modern use)	**10.3**	**9.8**	**9.9**	**9.6**
Nuclear	6.7	5.9	6.0	5.7
Hydro	2.2	2.2	2.4	2.4
Other renewables	0.5	0.6	1.2	2.2

Source: own calculations based on data from World Energy Outlook 2009, p.74.

Despite of the fact that the share of biomass is slightly decreasing, biomass was and will remain as the world's fourth source of energy, used mainly in the residential sector and to much lower extents in industry and transport sector, where oil is expected to dominate. Thus the need and importance to invest in biomass utilization projects are undeniable, as well as tailoring its corresponding legislation.

3. Key factors driving the need of bioenergy

Japan, being the world's 3rd largest economy after USA and China in terms of GDP, is the third largest electricity consumer, third oil consumer, and fourth natural gas consumer in the world . All fossil types of energy resources are imported, which makes Japan the second largest importer of fuels in the world (after the USA) and the third largest importer of oil (after the USA and China). This Country has insignificant deposits of coal, natural gas and oil; coal mining is heavily subsidized, and domestically mined oil and natural gas satisfy less than 2% of country's need in fossil energy carriers. Thus, Japan's need of bioenergy derives from the fact that the country has to import almost all energy carriers. So does Ukraine - in 2008, Ukraine's rate of energy dependence was 54.8% (Fig.2), which is comparable to that of EU-27 – 53.8%. Ukraine is willing to become a member of EU, but the latter, among others conditions, requires meeting 12% of the country's energy demand to be covered from renewables.

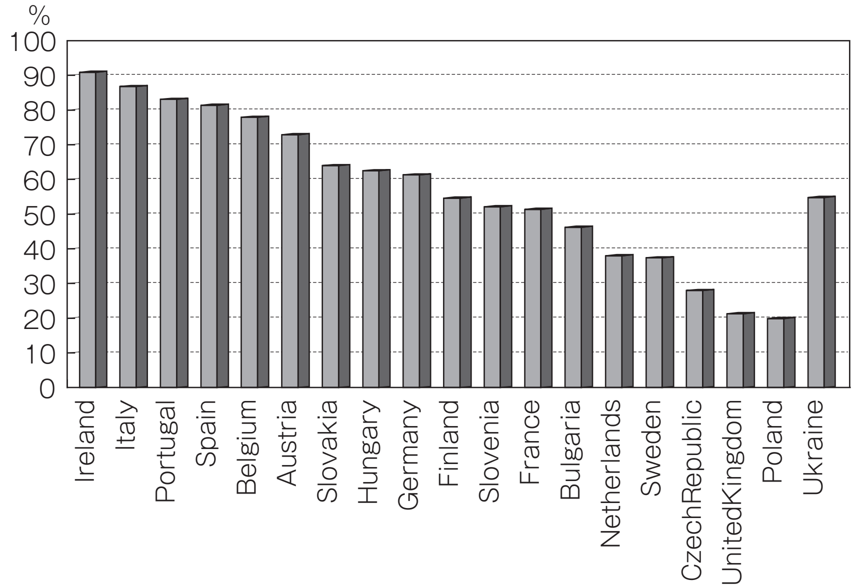

Fig.2　Energy dependence rate of EU-member states and Ukraine in 2008, %

Source : Europe's Energy Portal　http://www.energy.eu/

Other major reasons for Japan's need in bioenergy are precisely stated in "Biomass Nippon", which establishes the very concept of this industry development. These are the following:

- Revitalizing the rural communities through activation of agriculture, forestry and fisheries;

- Creation of a recycling-oriented society;
- Creation of new strategic industries.

Japan has declared a strong commitment under the Kyoto protocol to reduce its CO_2 emissions by 6% from the level of 1990 by 2010. In June 2009, the former Prime Minister of Japan Aso Taro obliged Japan to a 15% cut of green house gas emissions by 2020 in comparison to 2005 (8% cut from 1990 level), which was widely criticized. And in September 2009 Prime Minister Hatoyama Yukio proposed a 25% cut of the country's CO_2 emissions by 2020, relative to the level of 1990 [31].

One of the ways of such mitigation is a wide use of renewable sources of energy, as well as improvement of energy efficiency rate. But it is worthy to mention that Japan already has one of the best energy efficiency ratios among the industrialized countries in the world [32]. Even despite the fact that Japan has moved its heavy industry out of the country, it still remains a significant energy consumer (Table 10):

Table 10　Energy statistics for some countries in 2006

Country	**GDP per capita,** *USD*	**GDP,** *Bln USD PPP*	**Energy consumption,** *Mln toe*	**Energy intensity of GDP,** *Kg oe / USD PPP*	
				2006	**2001**
World	**5777**	**57564**	**11740**	**0.24**	**0.20**
Denmark	32573	170.07	20.93	0.14	0.12
Japan	**39817**	**3538.13**	**527.56**	**0.17**	**0.15**
Germany	24416	2254.73	348.56	0.18	0.15
France	23232	1694.97	272.67	0.19	0.16
Poland	5549	498.83	97.72	0.26	0.20
USA	37571	11265.20	2320.7	0.25	0.21
Check Republic	7059	196.69	46.05	0.30	0.23
Ukraine	**1035**	**307.61**	**137.43**	**0.72**	**0.45**
Russia	2618	1473.50	676.20	0.67	0.46

Source: Key World Energy Statistics. – Paris: International Energy Agency, 2008. – 80 pp.

Ukraine has neither significant environmental concerns, nor strict commitments to decrease GHG emissions, it even has the possibility to sell "hot air" (i.e. abundant quotas), neither to improve air quality. Nonetheless, major intentions to develop biomass industry are similar to those of Japan:

- to enhance development of rural communities;
- to satisfy energy needs, primarily those of agricultural producers, by means of biodiesel production;

- to decrease the country's dependency on energy imports;
- to improve the ecological situation;
- to revitalize the sugar processing industry.

Enhancement of rural communities' development is especially of high importance, as unemployment rate is very high there, and salaries in agriculture are the lowest in comparison to other sectors (Fig.3).

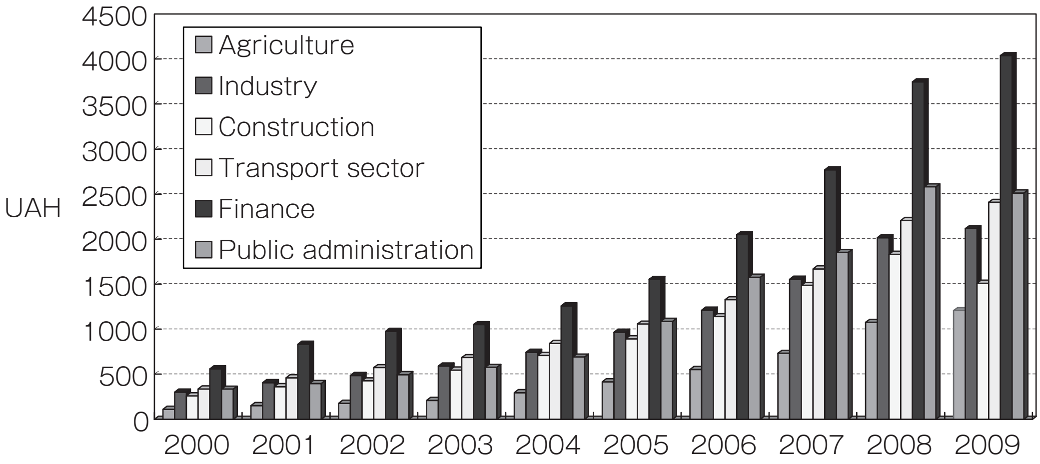

Fig.3 Dynamics of salaries in agricultural sector of Ukraine in 2000-2009, UAH

Source: State Committee of Statistics of Ukraine.

As we may see, the reasons to develop a bioenergy industry are similar in both Japan in Ukraine, i.e. countries are willing to decrease their dependence on energy imports, to rehabilitate rural areas, to improve the ecological situation. Japan is also willing to develop a "recycle-based society" [33], Ukraine - to rehabilitate the sugar producing industry. In case of both Japan and Ukraine, their bioenergy industries are relatively latecomers, especially in comparison with USA, EU or Brazil. A significant motive for Japan to develop its biomass sector is also the Kyoto protocol.

4. Current situation with bioenergy use

Current situation with bioenergy utilization in Japan is ambiguous: the share of biofuels for transport is negligible (due to lack of raw materials), but prospects are great, as the country is about to have commercial production of 2nd generation biofuels (Table 12). The capacity of existing ethanol plants is insignificant (Table 11) (by 2008 producing about 90 ths loe of ethanol), and use of ethanol had more of an experimental nature in certain prefectures until the introduction of the E3 blending mandate.

Table 11　Bioethanol production pilot projects in Japan

Location, developers	Supporting Ministry	Feedstock	Remarks
Tokachi district, Hokkaido, Tokachi Shinko Kiko	MAFF[48], METI[49], MOE[50]	Substandard wheat, corn	E3 experiment
Shinjo City, Yamagata Pref.	MAFF	Sorghum	E3 experiment
Sakai City, Osaka Pref., Taisei Corp, Marubeni, Osaka Pref.	MOE	Construction waste material	E3 experiment
Maniwa city, Okayama Pref., Mitsui Engineering and Shipbuilding Co., Ltd	METI	Waste material from a lumber mill	n/a
Kitakyushu-city, Fukuoka Pref., Nippon Steel Co., Ltd	METI, MOE	Food waste	n/a
Ie isl., Okinawa Pref, Ashai Breweries.	MAFF, METI, MOE, Cabinet Office	Molasses from sugar cane	E3 experiment
Miyako isl., Okinawa Pref.	n/a	Sugar cane	n/a
Demonstration projects			
Niigata-city, Niigata Pref. Capacity-1mln loe/year *	MAFF	Rice	Use model experiment
Tomakomai-city, Hokkaido, Oenon Holdings. Capacity-15 mln loe/year	MAFF	Rice	Use model experiment
Shimizu Town, Hokkaido, Hokkaido BioEthanol.	MAFF	Substandard wheat, sugar beet	Use model experiment

Source: Japan Country Report. APEC BIOFUELS TASK FORCE October 7-9, 2008 www.biofuels.apec.org/pdfs/apec_200810_ikeda.pdf ; Masayoshi Saito. Further promotion of biofuel production and consumption in Japan. June 2009; Pilot plant starts producing bioethanol from soft cellulose biomass 2010/03/26 http://www.japanfs.org/en/pages/029805.html

Apart from the three mentioned projects of soft cellulose processing, six companies of Japan, such as Nippon Oil Corp., Mitsubishi Heavy Industries, Ltd., Toyota Motor Corp., Kajima Corp., Sapporo Engineering Ltd. and Toray Industries Inc. agreed to conduct a research on production of cellulosic ethanol, namely for the production of 200,000 kiloliters of bioethanol per year at 40 yen per liter (about $0.44/l), which would allow competing with crude oil, by 2015 [34].

Nowadays, about 10 mln loe [35] of biodiesel is being produced in Japan [36], with the main production facilities shown in Table 13.

To meet the country's targets to reduce GHG emissions, Japan is obliged to import large quantities of biofuels (470 mln l of oil equivalent) and Japan imports ETBE [37] and biodiesel

Table 12　Soft cellulosic ethanol production in Japan

Location, developers	Supporting Ministry	Feedstock	Capacity
Akashi City, Hyogo Pref. Mitsubishi Heavy Industry Ltd., Hakutsuru Sake Brewing Co., Kansai Chemical Engineering Co.	MAFF	Rice straw, wheat straw (from Kansai City, Hyogo Pref.)	16 l/day. Cost of ethanol – 90 yen/l (0.98 USD/l)
Katagami City, Akita Pref. Akita Agricultural Public Corp., Kawasaki Plant Systems Ltd.	MAFF	Rice straw and rice husk (from Ogata Town)	200 l/day
Eniwa City, Hokkaido. Taisei Corp., Sapporo Breweries Ltd.	MAFF	Rice and wheat straw	3.7 l/day

Source: Japan Country Report. APEC BIOFUELS TASK FORCE October 7-9, 2008 www.biofuels.apec.org/pdfs/apec_200810_ikeda.pdf ; Masayoshi Saito. Further promotion of biofuel production and consumption in Japan. June 2009; Pilot plant starts producing bioethanol from soft cellulose biomass 2010/03/26 http://www.japanfs.org/en/pages/029805.html

Table 13　Major biodiesel production facilities in Japan

Location, developers	Feedstock	Capacity, *ths l/year*
Nagaoka City, Niigata Pref. Itami Auto Co., Ltd.	Waste edible oil, canola oil	240
Tottori City, Tottori Pref. Step Ltd.	Waste cooking oil	48
Akita City, Akita Pref. Bio Energies Japan Co., Ltd.	Waste cooking oil, sunflower oil	1590
Tsuchiura City, Ibaraki Pref. Suncare Fuels Co., Ltd.	Sunflower oil	300
Shisui Town, Chiba Pref. Toa Oil Co., Ltd.	Waste cooking oil	3000
Edogawa-ku, Tokyo. Ecodes Co., Ltd.	Waste cooking oil	120
Kurume City, Fukuoka Pref. Fuchigami Co., Ltd.	Waste cooking oil	500
Kogoshima City, Kagoshima Pref. Anzen Sangyo Co., Ltd.	Waste cooking oil, canola oil	585
Yamato Town, Kumamoto Pref. JA Kamimashiki	Waste cooking oil, canola oil	20
Aioi City, Hyogo Pref. Seiban Sekiyu Co., Ltd.	Waste cooking oil	240
Okayama City, Okayama Pref., Biodiesel Okayama Co., Ltd.	Waste cooking oil	1200
Shingu Town, Fukuoka Pref. Nishida Shoun Co., Ltd.	Waste cooking oil	2000
Toyama City, Toyama	Waste cooking oil	n/a
Kyoto City, Kyoto	Waste cooking oil	n/a
Iwaki City, Fukushima	Waste cooking oil	n/a
Shiogama City, Miyagi	Waste cooking oil	n/a

Source: Masayoshi Saito. Further promotion of biofuel production and consumption in Japan. June 2009;

(Fig. 4); considering the country's island location, transportation fares can be high, which makes the whole idea of biofuels import more expensive. Ukraine barely has any emission obligations, thus doesn't need to import biofuels, but having abundant resources for biofuels production, the country still has not managed not only to become an exporter of biofuels, but to consume those on the internal market, which will be shown in the following section.

Japan imports averaged 13.22% of the world's total net ethanol imports from 2006 to 2018, and 3.16% of the world's total net biodiesel imports from 2005 to 2018 (Fig.5.).

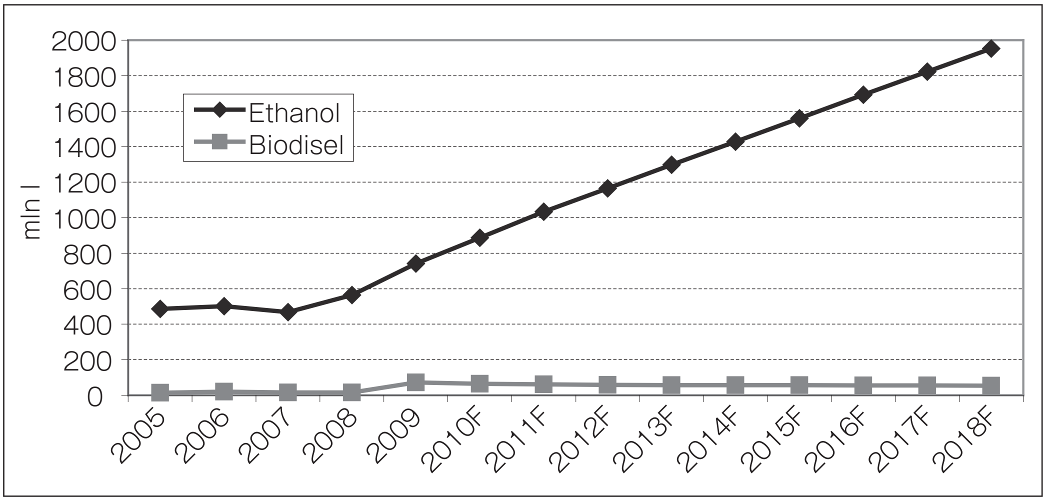

Fig.4 Japan's import of ethanol and biodiesel, *mln l*

Source: FAPRI 2010 Agricultural Outlook.

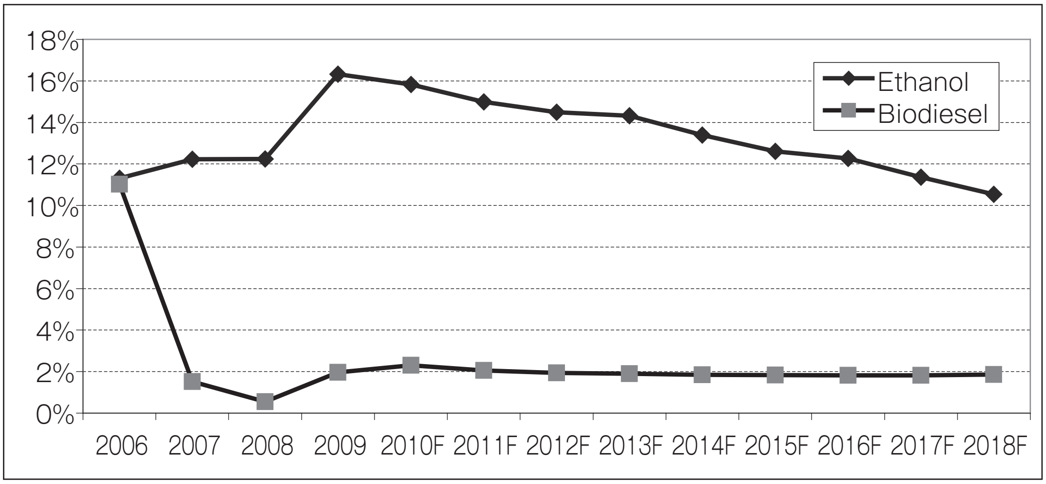

Fig.5 Share of Japan as a world importer of bioethanol and biodiesel, %

Source: own calculations based on FAPRI 2010 Agricultural Outlook.

Figure 5 shows that the actual peak of Japan's import of ethanol occurred in 2009; since 2010 FAPRI expects a decrease of ethanol imports in absolute value, a and steady decrease in relative value, and a certifying increase of international trade, which is absolutely natural considering that all countries have set up high targets for biofuel consumption, especially USA and EU. Japan's share of biomass and biogas use for production of heat is even more impressive (Table 14)

Table 14 Use of biomass and biogas for energy production in Ukraine and Japan in 2007

		Ukraine	**Japan**
Primary solid biomass	For heat production, *TJ*	0	0
	For electricity production, *GWh*	0	15757
Biogas	For heat production, *TJ*	0	5607
	For electricity production, *GWh*	0	0
Liquid biofuels		0	0

Source: International Energy Agency, www.iea.org

As we may see from Table 14, biogas is used in Japan primarily for heat production, and the number of biogas facilities is increasing: for instance, in 2005 there were 67 animal waste derived biogas facilities, 75 of those in 2006 and it was 76 of them in 2007. Despite Table 12 showing that biomass is used for electricity production, there is evidence that in 2005, the Japanese electric power supply companies seldom bought electricity from small-scale producers of electricity from biomass [38).

In Ukraine, biodiesel production is up to 80 ths t/year to partially cover the fuel needs of its producers; production capacity does not exceed 90 ths t. Rapeseed is a designated crop for biodiesel production. Regardless of those tiny amounts of biodiesel produced, the amounts of rapeseed planted are significant, and they were increasing annually, but 95% of rapeseed is exported to the EU (Fig.6), as export prices are high, heated by EU's biofuels consumption obligation.

Ethanol production in Ukraine reaches up to 20 ths t/year, and production capacity is about 220 ths t/year, where about 100 ths y/year of bioethanol can be produced at a private newly constructed biorefinery in Cherkassy region. In early 2010 that refinery was sold to a gasoline-retail company. The remaining 220 ths t/year are at the facilities of State Concern "UkrSpirt", which are supposed to be reequipped by 2011. Bioethanol production has got a strong lobby from sugar refineries as a chance to revitalize the industry, since sugar refineries have been running at less than 50% their capacity during the last 10 years. Substitution of 10% of petroleum gasoline with bioethanol will lead to a domestic market of bioethanol of

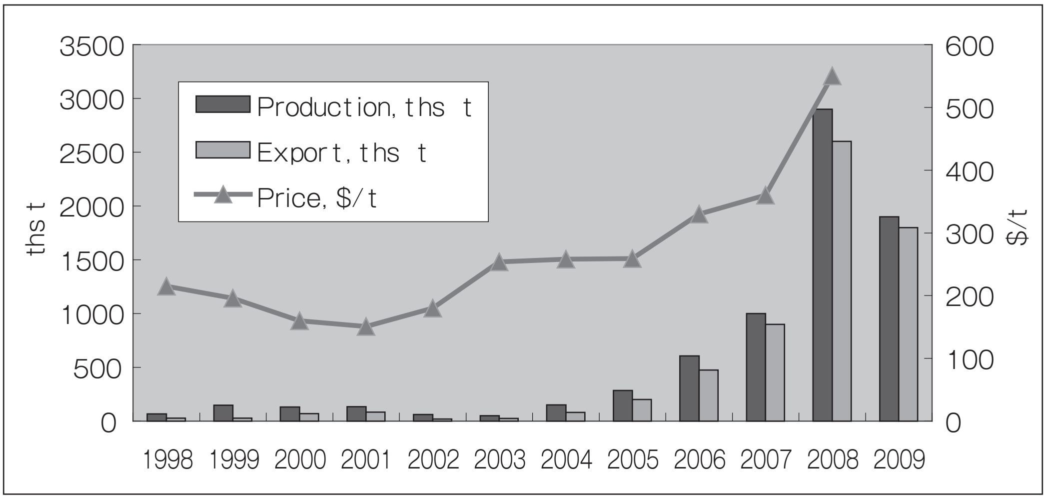

Fig.6 Dynamics of Ukrainian rapeseed production and export, and its export prices
Source: Toepfer International, www.acti.de

200-250 ths t/year.

Since December 2006 till April 2007, and December 2007 till now "Bioenergy Co. Energy Strategies and Technologies" sells fuels BIO100 and BIO 96 that are mixtures of bioethanol, benzene, light benzene fractions and 15% of methyl-tertiary-butyl ester. Certain pause in their production can be explained with a fact that for their production spirit oxygenate is required, which is produced only at State Concern "Ukrspirt". At the same time, the Concern claimed its own intention to produce bioethanol, which resulted in lack of spirit oxygenate at the market. As the result of this and some other issues, "Bioenergy Co." had to move its production to neighbor country Moldova, and to import BIO 100 and BIO 96 from Moldova, but these fuels were sold at 20 filling stations in Kyiv, Odessa, Chernivtsi and Dnipropetrovsk regions, so Ukraine became the first country in Eastern Europe who opened a dedicated filling station for bioethanol.

Self-cost of biogas is 20-27 euro/1000 m^3, self-cost of natural gas mining – 25-30 euro/1000 m^3. There are quite a few existing projects on biomass utilization in Ukraine – during early 2009 only 8 biogas plants were operating, and another 15 plants were going to start operation in Ukraine. Some of the projects are stated in Table 15:

Table 15　Major biodiesel production facilities in Ukraine

Location	Base	Source	Putting into operation	Capacity	Cogeneration plant capacity	
					Electricity, kW	Heat, kW
Kyiv reg., Velykyy Krupil	Dairy farm with 4000 cows	Dung	2009	Processing of 400 tons of dung a day	625	686
			2011- Plan	-	330	395
Kyiv reg., vil. Terezine	Farm with 2000 cows and 7000 pigs	Dung	2009	Processing of 100 tons of dung a day. Biogas output — 2160 m^3 a day	250	310
Chernvtsi reg., v.Luzhany	Luzhany sugar plant	Distillers grains with solubles	2010	2.300 m^3 of biogas a day	-	-
Dnipropetrovsk reg., v.Olenivka	18 000 pigs	Dung	2003	Processing of 80 tons of dung a day. Biogas output – 2000 nm^3 a day	160	320
City Zaporizhhya	Zaporizhzya oil plant	Vegetable residues	2011-Plan	Turbine 4 MW	-	50 t of steam an hour
Zaporizhzhya	Pif farm, 8-10 thousand pigs	Pig dung	1992-93	Processing of 22.6 m^3 of dung a day, biogas output 574 m^3 a day		
Kirovograd city	Kirovograd oil-extraction plant	Oil crops' husk	2009	Turbine 1,7 MW	-	48 tons of steam an hour
Kyiv reg., v.Stari Petrivtsi	Craft Foods Ukraine	Sewage water	2008	Processing of 540 m^3 of sewage water a day. Biogas output —2.400 m^3 a day		
Kyiv	National Agricultural University	Dung, straw, grains, glycerol	Unknown, looking for investors or budget funding	Processing of 17-18 ths t of feedstock a day; biogas output – 3500 m^3 a day	330	380

Source: various internet resources (in ukr.)

Biogas plants are expensive, which is a significant obstacle for their spread on the Ukrainian market. Lack of legislative requirement to utilize biological residues impedes their spread as well, thus one should not expect a rapid development of biogas market, especially considering that projects on landfill gas utilization are much more favorable for investors in Ukraine. To revitalize the market, a feed-in tariff was adopted, but as of May 2010, no single biogas producing company has received permission to obtain that tariff due to discrepancies in the definition of term “biomass” [39].

Table 16 Main importers of Ukrainian briquettes and pellets in November 2009, *t*

	Timber pellets	Timber briquettes	Sunflower husk briquettes	Straw pellets
Austria	40	21.6		21
Belgium		211.08		
Bulgaria		42		
Denmark	537.77	149.94		
Italy	873.68	244.99		
Lithuania	490.75	21.12	141.09	
Germany	**293.36**	**2177.77**	**80.54**	
Poland	**3714.71**	**254.32**	**1187.94**	**231.34**
Romania		22		
Slovakia	62.79			
Hungary	151.09	454.32		
Check Rep.	327.1	870.1		21
Total	**6491.25**	**4469.24**	**1409.57**	**273.34**

Source: Digest "Renewable Energy of Ukraine", JSC "Fuel Alternative", 2010, pp. 36,37 (in ukr.)

About 80% of pellets/briquettes, made in Ukraine, are exported to the EU, because they are used very widely there, being more than twice as expensive as in the Ukrainian market. For example, in 2008, 77 ths t of pellets and briquettes were produced in Ukraine, and 73 ths t were exported to the EU. High external demand lead to the increase of pellets/briquettes production – in 2009 260 ths pf pellets and 90 ths t of briquettes were produced. In May 2010, export prices for briquettes were 80-90 euro/t, wooden pellets –85 euro/t. In the EU pellets and briquettes are used by households, business sectors, but main consumers are thermal power plants. Major importing countries in the EU are provided in Table 16.

In 2010 external demand for pellets/briquettes began to fluctuate: in spring 2010 it had decreased, because Russian pellets/briquettes became a major competitor, and because the financial-economic crisis has led to a decrease of energy demand. Later on the external demand for pellets/briquettes grew again, but not as fast as in 2009, because the number of pellets/briquettes' producers had decreased, as well as the amounts of feedstock available. Companies processing sunflower, already install pellets/briquettes producing equipment, and thus do not sell this feedstock, so that the amounts of unused sunflower husk decreased annually (Table 17).

Domestic demand for pellets/briquettes in Ukraine emerges mostly for big private houses and cottage buildings, and not for large heat supplying enterprises. People install pellet boilers, because very often a connection to a natural gas pipeline takes too much time. In 2009, the

Table 17　Trends of sunflower husk utilization in Ukraine

	2004	2007	2009
Total amount of sunflower husk, *ths t*	427.940	656.808	1025.990
Burnt sunflower husk, *ths t*	274.774	425.550	760.880
Briquetted sunflower husk, *ths t*	32.626	82.833	255.670
Sold sunflower husk, *ths t*	**120.540**	**148.425**	**9.440**

Source: Amounts of sunflower husk pellets and briquettes export in 2009, prospects for 2010. 14-05-2010 http://www.fuelalternative.com.ua/content/analytic_view/ru/id,31908/ (in ukr.)

most popular types of boilers were those with capacity 90 -150 kW and a price up to 16 ths euro[40]. There are few exceptions for large scale users, for example Burshtynska TPP[41].

Main obstacles for pellets/briquettes market widening are the following:

- Decrease of prices for imported natural gas in 2010,
- Lack of stimuli or force to decrease GHG emissions;
- Low awareness of people regarding use of pellets/briquettes to satisfy own energy needs;
- High price for boilers;
- General wastefulness of people.

5．Policies and regulation

Ukraine has developed fairly significant number of laws and legal acts to regulate bioenergy market development, but, until recently, they had only a declarative nature, offering neither impetus nor pressure for bioenergy market creation, in other words they barely affected bioenergy market. Japan has adopted several strategies and plans of industry development that set up various goals and targets. Overall, Japan doesn't have a single national strategy of bioenergy development, which is also the case of Ukraine.

Major documents, shaping up Japan's bioenergy sector development, are the following:

- Biomass Nippon Strategy (2002 and reviewed in 2006);
- The Special Measures Law Concerning the Use of New Energy by Electric Utilities or Renewables Portfolio Standard Law (2003);
- Kyoto Protocol Target Achievement Plan (2005 and reviewed in 2008);
- New National Energy Strategy (2006);
- The Next-Generation Automobile Fuel Initiative (2007);
- Biofuel Technology Innovation Plan (2008);
- Law on the Quality Control of Gasoline and Other Fuels (amendment came in force since

25 Feb 2009);
- Act on Sophisticated Structure of Energy Supply (2009);
- Biofuels Sustainability Criteria of Japan (2009).

Biomass Nippon Strategy presumes usage of 25% of unused biomass and 80% of waste biomass for production purposes by 2020. These goals in livestock waste and black liquor utilization have already been surpassed.

After the 2006 revision, biofuels and biomass became a major object of the strategy. It presumed a creation of 300 biomass towns by 2010. The possibility to achieve that goal seems to be real (Fig.7), and major biomass cities so far are Sado (Niigata Pref.), Kasai (Hyogo Pref.), Maniwa (Okayama Pref.), Ie Village (Okinawa Pref.), Hita (Oita Pref.), Shirakawa Town (Gifu Pref.), Motegi Town (Tochigi Pref.), Kosaka Town (Akita Pref.), Shimokawa Town (Hokkaido)[42].

As early as in 2003 Japan has implemented the Renewable Portfolio Standard with ***"The Special Measures Law Concerning the Use of New Energy by Electric Utilities or Renewables Portfolio Standard Law"***. This law obliges electricity retailers to use annually certain amount of their retailing electricity from renewable sources. These renewable sources include geothermal generation, small size hydro (up to 1 MW of installed capacity), biomass, solar and wind generation. Electricity retailers, who have that obligation, may choose one of three options to satisfy it: a) to generate electricity by themselves; b) to purchase green electricity from another party; or c) to purchase New Energy Certificates from another party. Entities willing to generate green electricity are obliged to obtain accreditation from Ministry for Economy, Trade and Industry. In reality, grey power generating companies prefer generating their own green electricity rather than buying it from small companies generating electricity from renewables. As of March 2007, about **333.898** green energy-generating

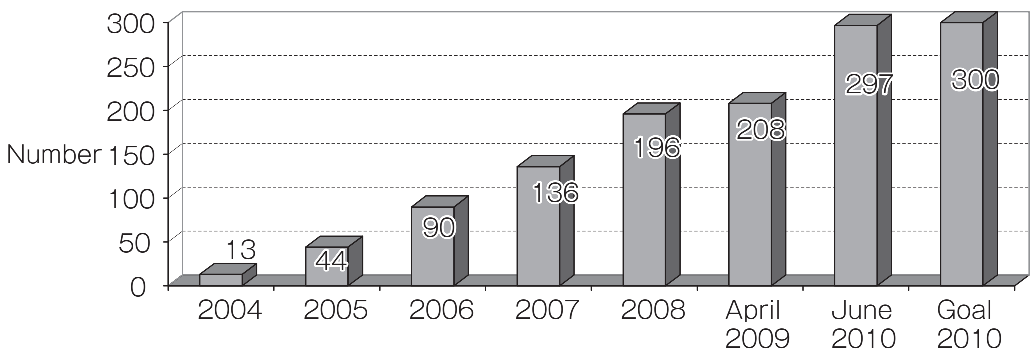

Fig.7　Number of actual and planned biomass cities in Japan

Source: Masayoshi Saito. Further promotion of biofuel production and consumption in Japan, June 2009.

facilities were accredited to produce green electricity with total capacity of **12.630.846** kW. Annual green electricity utilization targets (Fig.8) are established by the Ministry of Economy, Trade & Industry.

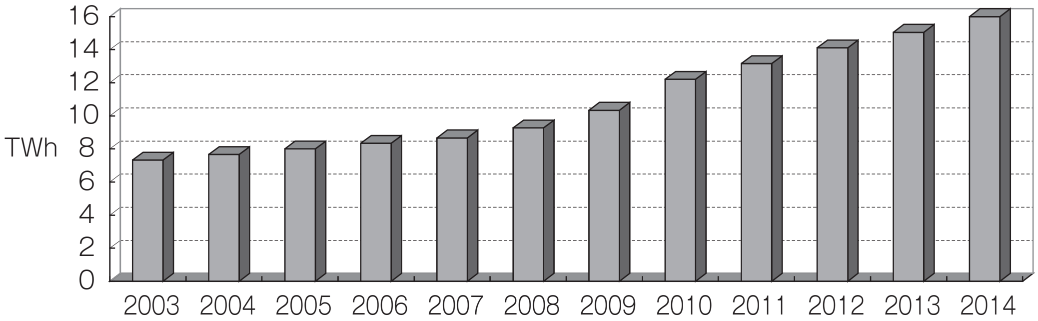

Fig.8 Green Electricity utilization Targets in Japan, TWh/year

Source: What is RPS in Japan?, www.rps.go.jp/RPS/new-contents/english/inEnglish.html

As of June 2007, there were 36 electricity retailers, obliged to use green electricity in Japan.

Kyoto Protocol Target Achievement Plan sees a promotion of biomass utilization as one of the main efforts in the energy conversion sector; the amount of biofuels production had to reach 500 mln loe by 2010. The Plan anticipates that the Government will promote economic incentives such as a biofuel associated tax system; establishment of cellulose utilization technology (e.g., use of rice straw) to avoid competition with food; large-scale demonstration towards the expansion of domestic biofuel production; technological development towards the utilization of highly-concentrated biofuels in vehicles [43).

New National Energy Strategy of Japan, among other acute issues such as the increase of nuclear power generation and others, the strategy focuses on the promotion of energy source diversification, thus oil dependence in primary energy mix is expected to be lowered to 40% in 2030, and the country's oil dependence in transportation fuel is expected to be lowered to 80% in 2030 (from 98% in 2000). It anticipates creation of infrastructure for biofuels, as well as a significant shift towards increased use of biodiesel, and Gas-to-Liquid fuels, i.e. fuels produced using synthetic gas made from natural gas [44). A total target of 20% transport fuel, other than gasoline and diesel are to be consumed in the country by 2030 [45).

Law on the Quality Control of Gasoline and Other Fuels presumes blending of up to 3% in volume of ethanol to gasoline, and blending of up to 5% in volume of biodiesel to diesel fuel. Oil processing companies committed using of 210 mln loe of ethanol in form of ETBE starting in 2010 [46). This commitment is definitely remarkable per se, nonetheless they claim that ethanol is water-absorbing and water-soluble, thus additional investments in infrastructure are required to get distribution going and direct blending of ethanol with gasoline to obtain E3 blend. Overall, oil processing companies (except Petrobras) do not support use of E3 direct blended gasoline. In 2007 Government has launched several aid projects for test sales of ethanol at 50 service stations. In 2008 their amount reached approximately 100, and about 1000 in 2009. Test studies of direct ethanol blending were carried at regional level by Ministry of Environment and local governments. Use of biodiesel was also tested, for example in the city of Kyoto, where biodiesel is used in the system of public transportation as the blend B20, being purchased from nearby producing neighborhoods. Blend B100 is used to fuel garbage trucks and private vehicles.

More specific targets for biomass utilization were the following:
1.420 mln loe of biomass utilization for thermal power plants purposes by fiscal year 2005, and 3.080 mln loe by fiscal year 2010, which includes 5 mln loe of biomass-derived fuels for transportation[47].

Biofuel Technology Innovation Plan presumes a development of technological innovations for production of cellulosic ethanol to avoid competition with food production by 2015, targeting production of lignocelluloses biofuels at an amount of about 100-200 mln loe annually. Ethanol production cost is expected to be 40 yen/l, which requires high yielding biomass production, as well as increase of efficiency of main conversion technologies and processes, such as biomass pretreatment, saccharification, fermentation, etc.

The ***Next-Generation Automobile Fuel Initiative*** successfully endorses biomass-derived biofuels into the structure of future fuels, clearly envisaging the strategy not only for the fuel development, but also for engines and fuel's infrastructure. It includes projects for next-generation vehicles on batteries, fuel cells, creation of clean and fuel-efficient engines for diesel fuel, and a strategy for safe expansion of 2nd generation biofuels. The latter in particular included the following steps:
- setting up the biofuels technology innovation council (consisting of institutions from industrial, academic and government sectors);
- establishment of systems and infrastructures to secure quality and prevent tax evasion;
- advent of next-generation domestic biofuels, costing 100 yen per liter in 2015 (Biomass Nippon) with its further reduction till 40 yen/l.

Main fiscal instruments of biofuels production and promotion of their use in Japan are the following:
- 1.6 yen/liter fuel tax reduction for bioethanol blend E3 from May 2008 (gasoline tax – 53.8 yen/l (consisting of gasoline excise 48.6 yen/l+ local road tax 5.2 yen/l), oil and coal tax –

2.04 l, consumption tax – 5%);
- 50% reduction of fixed asset tax for biofuels plants for 3 years from October 2008 (applicable for ethanol, biodiesel, biogas, pellets producing facilities). The reduction is applicable only to newly constructed facilities [48];
- zero interest rates loans;
- exemption of biofuels from gasoline tax and local road tax for 5 years starting from 25 February 2009;
- 50% reduction of fixed asset tax for new constructed ethanol, biodiesel, biogas, pellets producing facilities [49] for 3 years starting from October 2008;
- Exemption of biofuels from gasoline tax and local road tax for 5 years from February 2009.

These were the main documents defining policy mechanisms to promote bioenergy use in Japan. The main laws regulating bioenergy development in Ukraine are the following"
- Law on electric energy (1997);
- Law "On alternative liquid and gas fuels" (2000);
- State Program "Ethanol" (2000);
- Law "On renewable sources of energy" (2003);
- Law "On biofuels" (2003);
- Law "On combined production of heat and electroenergy (cogeneration)" (2004);
- Energy Strategy for Ukraine till 2030 (2006);
- State Program "Production of diesel biofuel" (2006);
- Decree of Cabinet of Ministers of Ukraine "On approval of lists of companies with all stages of the process to manufacture petroleum products that are entitled to produce motor gasoline mixtures containing ethyl-tertiary-butyl-ether or additives based on bioethanol, and state alcohol factories that are eligible for the production" (2007);
- Law "On some laws' amendments regarding promotion of production and use of biofuels" (2009).

Unfortunately, the majority of these papers were solely declarative, neither setting any targets on bioenergy utilization, nor offering any actions on ways to achieve the targets. The most important programs and laws are listed below.

State Program "Production of diesel biofuel" was supposed to last until 2011, assuming subsidies to producers of agricultural crops, development of zones for rape production; incentives for use of biodiesel by agricultural firms; setting up mandatory targets for increase of biodiesel production; development of standards for use of biodiesel; 8% financial help for R&D and for modification of engines. None of the mentioned deeds were ever completed except for the development and implementation of a biodiesel quality standard, which was done in March 2010, i.e. when the program was almost expired. The program was absolutely ungrounded, especially in regards of the financing of the construction of 23 biodiesel plants, which was supposed to be done at investor's expense. These projected plants were supposed to produce up to 623 ths t of biodiesel in 2010 (Table 18).

Table 18　Goals declared by State Program "Production of diesel biofuel"

	2008	**2009**	**2010**
Potential of rapeseed production, ths t	3000	3600	5400
Rapeseed for biodiesel, ths t	300	900	1890
Potential of biodiesel production, ths t	**100**	**300**	**623**
Needs in fuel for a/g producers, ths t	1870	1870	1870

Source: State Program"Production of diesel biofuel" (2006).

Energy Strategy of Ukraine till 2030 [50] presumes a nuclear path for the national energy sector development, suggesting maintenance of 13 existing nuclear power units and construction of 22 new ones to decrease natural gas consumption, refusing structural and technological energy saving and giving a very modest role to renewables. This path carries socio-economic, ecological and political threats, bearing in mind that currently Ukraine does not have a closed cycle of nuclear fuel production, importing 70% of it from Russia. Currently, electricity from renewables, namely from use of wind energy, contributes about 1% in the country's energy balance, while solar energy for production of electricity is not used at all, and use of biomass is limited mainly to production of heat. Targets for renewables use in Ukraine are stated in Table 19.

Table 19　Actual and forecasted amounts of energy from renewables in Ukraine, mln t c e

Source	**2005**	**2010**	**2020**	**2030**
Bioenergy	**1.3**	**2.7**	**6.3**	**9.2**
Coalbed methane	0.05	0.96	2.8	5.8
Small hydro energy	0.12	0.52	0.85	1.13
Solar energy	0.003	0.032	0.284	1.1
Geothermal energy	0.02	0.08	0.19	0.7
Wind energy	0.018	0.21	0.53	0.7
Total	**1.511**	**4.502**	**10.954**	**18.63**

Source: Order of Cabinet of Ministers of Ukraine #145- p from 15 March 2006 "On approval of Energy Strategy of Ukraine till 2030"

Bioenergy and coal bed methane are two the most prospectus sources of renewable energy in Ukraine. Considering significant technological difficulties of mining of coal bed methane in Ukraine and its very limited actual use, utilization of its potential is delayed indefinitely. In the mean time, biomass is being used with traditional technologies such as burning. An arsenal of new technologies is highly promising, but its rapid commercialization cannot be foreseen. It was expected, that the total amount of investment to fully utilize biomass potential will be $2.4 bln by 2030, but a lack of corresponding programs, and, mainly the financial-economic crisis would not make that happen.

Law on electric energy[51] introduced the concept of a green (feed-in) tariff as a special tariff to purchase electricity, produced by the plants of electric energy using renewables (in case of hydroenergy – produced by small hydroenergy plants). Wholesale electricity market of Ukraine is obliged to purchase with green tariff all electricity produced by power facilities using renewables that were not sold directly to consumers or electricity distributing companies. In other words grid access is guaranteed by law, which is a major advantage of the current legislation. Its significant disadvantage is that there are several national policy papers defining a general use of energy from renewables, but there is no vision/target on a national level of how much electricity from renewables has to be consumed. Besides, companies installing equipment that generate electricity from renewables, for example from biomass-derived biogas, fail to obtain permits to sell electricity with the green tariff because of existing discrepancies in its definitions, whereas only those companies that generate electricity from biomass qualify for a green tariff[52].

Electricity produced from renewables can be sold with the green tariff based on direct contracts with consumers, but green electricity is very expensive, so consumers have no incentives to buy this electricity, and at the same time they are not forced to do it, since there is no Renewable Portfolio Standard or its analogue. The size of the green tariff is fixed for each entity that produces electricity from renewables, each type of alternative energy and power for each plant. Sizes of green tariff for entities generating electricity from wind energy, biomass, are set at the level of retail tariffs for consumers of second-class voltage at the level of Jan 2009, multiplied by a coefficient of green tariff for electricity generated from wind energy and biomass respectively (Table 20). Sizes of green tariff for entities generating electricity from energy of solar radiation and small hydroenergy, are set at retail rates for consumers of second-class voltage at the level of Jan 2009, using a tariff rate applicable for peak period, multiplied by a coefficient of green tariff for electricity produced mainly from solar radiation energy and secondarily from hydroenergy.

Table 20　Coefficients of feed-in tariffs in Ukraine

Coefficient	Source of electricity
4.8	Sun from ground-installed objects
4.6	Sun from roof-installed objects, whose capacity does not exceed 100 kW
4.4	Sun from roof-installed objects, whose capacity does not exceed 100 kW and for other solar objects installed on building facades with any capacity possible
2.3	**Biomass**
2.1	Wind energy from facilities with capacity more than 600 kW
1.4	Wind energy from facilities with capacity between 600 kW and 2000 kW
1.2	Wind energy from facilities with capacity less than 600 kW
0.8	Small hydropower plants

Source : Law on electric energy #575-97/VR, adopted on 16 October 1997, and amended on 17 November 2009.

An issue about the licensing of green electricity requires further improvement, mainly regarding registration of green electricity producing companies. Nonetheless, adoption of feed-in tariff in Ukraine has already resulted in several plans announced to build 6 new onshore wind farms in Ukraine with total capacity of 2676.25 MW by 2013. In Feb 2010, sizes of green tariffs were decreased 1.3%, due to a change of the euro exchange rate. According to the legislation on feed-in tariff, any judicial entity can provide electricity into the grid, but in practice an electricity-producing equipment has to have a capacity of more than 5 kW, because equipment like this or higher capacity requires permissions from national Inspections of Ukraine (such as State Committee of Ukraine for Labor Protection, Electric Inspection Service, State Gas Inspection).

An issue of high importance is the connection of power cogeneration plants to the grid. In general, current legislation provides legal framework for simple access of cogeneration facilities to the grid. Despite the presence of rules for cogeneration facilities, current market of cogeneration is only at its initial stage, and requires implementation of soft loans for the purchase of cogeneration plants; VAT exemption for manufacture of cogeneration plants; favorable loan programs for construction companies, associations (e.g., houses) who want to install such equipment; spread of information regarding of prospects of renewables and strengthening of the demand side.

The best prospect for renewable electricity production in Ukraine is related to energy from the wind, whereas energy from the sun and biomass are used mostly for heating purposes. Prospects of private financing of renewables projects are modest due to economic decay, caused by the current financial and economic crisis. Despite policies and legislation for inclusion of electricity from renewables into the general grid in place, there are some technical obstacles for it. Even knowing that costs of electricity produced per unit of energy in isolated grids are higher, isolated grids are getting more and more popular, but implementation of green feed-in tariff has already triggered development of wind-related projects, and would create relatively transparent conditions for corresponding investments in the medium-term.

Decree of Cabinet of Ministers of Ukraine ***"On approval of lists of companies with all stages of the process to manufacture petroleum products that are entitled to produce motor gasoline mixtures containing ethyl-tertiary-butyl-ether or additives based on bioethanol, and state alcohol factories that are eligible for the production"*** defines a list of enterprises allowed to blend bioethanol (up to E5), namely joint stock companies "Naftokhimik Prykarpattya", "Lukoil - Odessa oil refinery", "Hersonnaftopererobka", "Shebelinskyi gas processing plant" and" Ukrtatnafta, i.e. all existing large oil processing plants.

Law on some laws' amendments regarding promotion of production and use of biofuels was the most significant law for biofuels market formation, which gave numerous fiscal preferences to bioenergy users, biofuels producers, as well as to equipment importers since the beginning of 2010. Another important novelty became a demonopolization of ethanol production by SC "Ukrspirt", so ethanol for bioethanol production can be produced by any legal entity having the necessary equipment and license. Major fiscal measures include zero excise rate on biological component of fuel blend; VAT exemption for biofuels producers for 10 years since 2010; exemption of import duty and VAT for imported equipment until 2019 etc. This Law became a breakthrough for the entire bioenergy industry; nonetheless it misses one significant aspect of biofuels market realization – namely biofuels blending mandates.

Factors impeding development of biogas market in Ukraine are a lack of internal funds of enterprises, as well as limited credit possibilities (because there are no long-term loans in Ukraine, and because banking systems are still trying to recover from the last financial-economic crisis; high price of biogas plants (1-10 mln euro); decrease of natural gas prices since April 2010 p.; indifferent ecological legislation that does not encourage enterprises to utilize sewage water and wastes.

Knowing the major traits of Japanese and Ukrainian bioenergy industries, we approach to the very essence of this paper – a comparison of policies regulating the bioenergy industry. The following table offers a major comparison of Japan and Ukraine bioenergy regulation issues.

Table 21　Comparison of bioenergy market regulation features of Japan and Ukraine

Feature	Japan	Ukraine
Support of Ministries	+	+
Concurrence of Ministries actions	+	-
Blending mandates of biofuels	+	-
Indicative targets of bioenergy utilization	+	+
Fiscal incentives	+	+
Standards of biofuels quality	+	+
Standards of pellets quality	+	-
Biofuels blending regulations	?	-
R&D, financed from state budget	+	+
R&D of 2nd generation biofuels financed from state budget	+	-
Price subsidies	-	-
Pilot projects, business model development	+	+
Protective tariffs for wooden pellets/briquettes	+	-
Protective tariffs for biofuels	-	-

This table requires certain comments and explanations. As it was shown in the Table 19, Ukraine did have indicative targets of bioenergy consumption, but the targets indicated are not only hard to reach, but also they are not grounded in terms of their achievability, first of all regarding the construction of facilities to utilize the biomass potential in Ukraine.

Table 21 shows that Ukraine has standards of biofuels quality. Ukrainian national standard for biodiesel was awaited for nearly 5 years, which was one of the significant obstacles for biodiesel markets creation. In other words, one could not prove its quality, thus it was difficult to sell that good.

As it was told above, all the pellets/briquettes produced in Ukraine, are exported out of Ukraine, primarily to the EU. At the same time, there are no national standards for wooden pellets.

In regard to the biomass pilot projects, there are those mainly in frame with Universities' work. Universities are looking for financing of projects, not always being able to find it, which is the case with the announced plans to create a biorefinery at National Agricultural University (Kyiv, Ukraine). Furthermore, let us compare the main features of regulation of biomass utilization to obtain electricity (Table 22).

Table 22　Regulation of electricity from biomass and biogas production and consumption

	Japan	Ukraine
Feed-in tariff	-	+
Access to grid guaranteed by law	-	+
Constant and predictable feed-in tariff	-	+
Stimuli for private consumers to purchase green electricity	-	-
Consistency of duties and actions between ministries	+	-
R&D	+	+
Transparency of licensing procedure	+	+
Pilot projects	+	-
Renewable Portfolio Standard	+	-

A state-funded R&D support in Ukraine is very small, conducted primarily within institutions of National Academy of Sciences of Ukraine. The simple explanation for this is limited financial possibilities of the economy in general, lack of priority to develop renewable energy sources, as well as unfavorable conditions for entrepreneurship.

As of feed-in tariff in Japan, there is one in place, but it applies only to solar power, and not to other renewables, being valid only for 10 years. Nationwide use of feed-in tariff system in Japan began on Nov 1, 2009, and since then it has been criticized and opposed, as the size of it is very high (48 yen/kWh compared to 5-7 yen/kWh for nuclear power and 8 yen/kWh for oil-fired generation), renewable energy per se is artificial and unable to cover the country's energy needs. In case of feed-in tariff spreading for other types of renewables, this could hamper interests of nuclear reactors owners, as “grey” energy will be slowly squeezed out by its “green” rival. Utilities oppose feed-in tariff claiming that feed-in tariff will increase people's electricity bills and they would start complaining about it [53], but despite such a high tariff, consumers' average bill will become only $1 a month higher. In spring of 2010, there were debates on the spread of feed-in tariff for electricity produced from wind, hydropower and geothermal energy. Utilities will have to buy electricity for 15 and 20 yen/kWh within 10-20 years [54]. Since Japanese feed-in tariff is restricted and it is not applicable to biomass, it is fair to say that there is no feed-in tariff for biomass in Japan, and it allows drawing a major conclusion of need of such a tariff. In the case of electricity from biomass utilization, the fact that Ukraine has comprehensive feed-in tariff, is about to bring good results. Ukrainian experience in creation of feed-in tariff system and its implication may be of some interest for Japan to develop its own progressive policy.

In Japan, biofuels are a part of existing and future infrastructure, which will coexist with electromobiles, etc. As of Ukraine, the authors are not aware of any Program envisaging or shaping out a future for the country's transport sector (one of the possible major reasons is that this country has an insignificant position as an automaker).

Overall, Ukraine and Japan have more differences than similarities in bioenergy market development and these differences derive not only from different financial possibilities of the state funding of bioenergy projects. Japan citizens overall have high civic consciousness [55)] about environmental issues and care for the environment (for example, processing of used cooking oil into biodiesel in Kyoto since 1997), which is not the case of Ukraine, and this very factor is of very high importance, because lack of final consumers support will make any properly tailored governmental program a failure.

Overlook of legislation and study of existing biofuels production facilities bring us to conclusion that in Japan, stimulation of both supply and demand side has taken place, whereas in Ukraine we may observe only stimulation on the supply side. The implication is a lack of demand of biofuels because nobody knows about biofuels properties, vehicles characteristics, systems of distribution etc.

Both Japan and Ukraine have a wide range of economic incentives for biofuels production, which is supposed to give a chance of inexpensive biofuels to consumers. Reality is quite the opposite: in Ukraine unhydrated 1st generation ethanol is more expensive than petroleum. In case of biodiesel, demand and thus high export prices for rapeseed remain low chances for wide-scale domestic production and consumption of biodiesel, even though since 2010 any biofuels producer may enjoy very favorable fiscal incentives.

Unlike in Ukraine, commercial blenders as economic entities exist in Japan. Under the current legislation, blending of bioethanol to gasoline is supposed to take place at the oil-processing plants, which does not happen in reality, while legislation does not consider blending of biodiesel.

In Ukraine, production of ethanol has got significant governmental and lobby support, because it is seen as a way to rehabilitate the sugar refining industry, and to convert existing abundant sugar plants into ethanol producing plants. Biodiesel production is happening mostly due to local initiatives. This is partially the reason of why the program on biodiesel production failed, which anticipated an absolutely unrealistic and financially unsupported program of annual production of 0.623 mln t of biodiesel/ year and the construction of a corresponding number of biodiesel plants. Nonetheless, there are no blending mandates for any biofuels, unlike in Japan, where a mandate of 3% blending mandate for ethanol (E3) was set up. This moderate rate is a reason of vehicle performance concern, as well as careful calculation of GHG emission, while no blending mandate in Ukraine is a reason of strong oil lobby opposition.

6. Conclusions

Ukraine has much more land and feedstock available to obtain all kinds of energy from biomass, as well as more mechanisms and financial incentives to develop a bioenergy market, nonetheless Japan has gone much further in bioenergy practical implementation. The reasons for this factor are the following:

- despite the fact that regarding to the biofuels spread Japan is a “latecomer”, the country has adopted its legislation earlier than Ukraine;
- Biomass Nippon was constructive and detailed from the very time of its adoption, whereas Ukrainian legislation for a long time was of declarative nature;
- enormous profits are not common for entrepreneurs in Japan; thus profitability up to 7%, which can be yielded from biomass-utilization projects, is acceptable in Japan, which is not always the case in Ukraine;
- transaction costs in business in Japan are lower that those in Ukraine, the enterpreneural environment is more friendly to start business in Japan; economical and political situation are much more stable in Japan;
- in terms of directs subsidies, both Japan and Ukraine provide major direct subsidies for R&D, but Japan also subsidies pilot projects and biomass utilization plants construction.

For Japan to achieve its declared goals on biomass utilization in general and on biofuels consumption in particular, the Law on the Quality Control of Gasoline and Other Fuels needs to be amended, that would guarantee higher blending rates of biofuels, so MAFF is already working on E10 blends. This, in turn, requires a proportional taxation system – the higher biological component in the blend, the lower tax should be, and vice versa. For Ukraine to increase its use of biofuels, a fuel blending mandate is absolutely necessary. Overall, the renewable energy sector of Japan is more policy driven, whereas Ukrainian market is more market driven (concerning export of rapeseed, as well as export of pellets/briquettes etc).

Energy production from renewables in general is an infant industry, thus experience of its regulation is relatively limited. Ukraine must learn from Japan the following things:

- development of society concerned with recycling;
- realistic program provisions and targets for biomass consumption;
- stimulation of demand for bioenergy.

This paper has concluded that an efficient and properly tailored energy policy, as well as a general trend toward increased value of environmental care are the key factors enabling development of bioenergy market. It is worthy to notice that in case of electricity from biomass, the legislation of Ukraine is better designed than the one of Japan in terms of comprehensive feed-in tariff in place, obligatory access to grid for electricity from biomass, as well in terms of predictability of electricity tariffs.

Notes

1） Preparation of this paper became possible thanks to generous fellowship of The Japan Foundation in frame of the Program for Intellectual Exchange of Japan Foundation, provided to Dr. G. Trypolska.

2） The Japanese energy sector: Current situation, and future paths. Energy Policy (2010). Article in Press. Takase Kae, Tatsujiro Suzuki.

3） Japan Bio-Fuels Production Report. 2006. www.fas.usda.gov/gainfiles/200605/146197881.pdf .

4） Current situation and prospect of biomass utilization in Japan. Yukihito Matsamura, Shin-ya Yokoyama. Biomass and Bioenergy 29 (2005) 304-309.

5） Woody biomass supply potential for thermal power plants in Japan. Tsuguki Kinoshita, Takashi Ohki, Yoshiki Yamagata. Applied Energy Vol.89, Issue 9 (2009) 2923-2927.

6） Biomass resources present in Japan – annual quantities grown, unused and wasted. Eiji Minami, Shiro Saka. Biomass and Bioenergy. 29 (2005) 310-320.

7） Woody biomass resources and conversion in Japan: The current situation and projects to 2010 and 2050. Takuyuki Yoshioka, Satoshi Hirata, Yukihiko Matsumura, Kinya Sakanishi. Biomass and Bioenergy 29 (2005) 336-346.

8） Lee Chung Lau, Koktat tan, Keat Teong Lee, Abdul Rahman Mohamed. Energy Policy 37 (2009) 4771-4778.

9） Biofuel initiatives in Japan: Strategies, policies, and future potential. Naoko Matsumoto, Daisuke Sano, Mark Elder. Applied Energy 86 (2009) S69-S76.

10） V. Ya. Mesel-Veselyak. Efficiency of energy self-sufficiency of agriculture. - 2009. Economics of Agriculture. - № 2. - P.10-14 (in ukr.).

11） Energy potential of forest residues in Ukraine http://www.ive.org.ua/atlas_04.htm (in ukr.).

12） State Committee of Forestry of Ukraine has suggested to develop a program on biofuels use 20-01-2009 http://www.fuelalternative.com.ua/content/nview/ru/id,25766/pn,3/ (in ukr.).

13） Zabarnyy G., Kudrya S., Kondratyuk A., Chetverin G.. Thermodynamic efficiency and resources of liquid biofuels of Ukraine. –Kiev: Institute of renewable energy, UAS, 2006. – 226 p. (in ukr.).

14） M. Pugovytsya Window to Asia was made. What for a native country? UkrAgroPortal. # 72 (2003) http://www.ukragroportal.com/propoz/item.html?PropozRubID=3&Year=2003&NumID=&obl=&ItemID=1012&Page=0 (in ukr.).

15） M. Pugovytsya. Not only with rapeseed… Government courier. – 27.11.2007. – #222. – p.7 (in ukr.).

16） D.B.Rakhmetov. New introduced species in fitoenergy sector of Ukraine. National botanic garden named after N.N.Gryshko (in ukr.).

17） L.Futerko Use of woody biomass as an alternative source of energy. Ecology systems, #5, 2006. http://www.esco-ecosys.narod.ru/2006_5/art31.htm (in ukr.).

18） Biomass action plan for Ukraine. 2009. – Kyiv. – 44 p. Ministry of agricultural policy and Agency SenterNovem of Ministry of economics of the Netherlands. (in ukr.).

19） Even though the data for Ukraine are only for 2004, the structure of primary energy supply in Ukraine has not changed significantly, and the share of renewables (excluding large hydro) does not exceed 1% even in 2010.

20） Hisao Fukuda, Aaron Kingsbury, Kakayu Obara. Japan. Bio-Fuels production report. 26 May 2006.

21） Biomass resources present in Japan – annual quantities grown, unused and wasted. Eiji Minami, Shiro Saka. Biomass and Bioenergy 29 (2005) 310-320.

22） 1 ton of crude oil is 1.16 kl of crude oil. 1 t of crude oil is 1160 l of oil. 1 l of oil is 1000 kg/1160 = 0.862069 kg. Thus, 1 l of oil equals 0.862069 kg of oil. **1 kl of oil equivalent is** 1000*0.862069 kg of oil ＝ 862.069 kg of oil ＝ **0.862069 t of oil equivalent**.

23） V. Ya. Mesel-Veselyak. Efficiency of energy self-sufficiency of agriculture. - 2009. Economics of Agriculture. - No. 2. - P.10-14.

24） Biomass action plan for Ukraine. 2009. – Kyiv. – 44 p. Ministry of agricultural policy and Agency SenterNovem of Ministry of economics of the Netherlands. (in ukr.).

25） M. Pugovytsya Window to Asia was made. What for a native country? UkrAgroPortal. # 72 (2003) http://www.ukragroportal.com/propoz/item.html?PropozRubID=3&Year=2003&NumID=&obl=&ItemID=1012&Page=0 (in ukr.).

26） M. Pugovytsya. Not only with rapeseed… Government courier. – 27.11.2007. – #222. – p.7 (in ukr.).

27） D.B.Rakhmetov. New introduced species in fitoenergy sector of Ukraine. National botanic garden named after N.N.Gryshko (in ukr.).

28） Energy potential of forest residues in Ukraine http://www.ive.org.ua/atlas_04.htm (in ukr.).

29） L.Futerko Use of woody biomass as an alternative source of energy. Ecology systems, #5, 2006. http://www.esco-ecosys.narod.ru/2006_5/art31.htm (in ukr.).

30） State Committee of Forestry of Ukraine has suggested to develop a program on biofuels use 20 January 2009 http://www.fuelalternative.com.ua/content/nview/ru/id,25766/pn,3/ (in ukr.).

31） Andrew DeWit Regime Change Short-Circuited: Carbon Emissions and Japan's Feed-in Tariff System. http://www.japanfocus.org/-Andrew-DeWit/3249.

32） The Japanese energy sector: Current situation….

33） Biomass Nippon.

34） Joint Research to Develop Cellulose Bio-Ethanol by 2015. 06 May 2009 http://www.japanfs.org/en/pages/028959.html.

35） liters of oil equivalent.

36） National Policies on Automotive Biofuels in Japan. Fukumi NISHIMAKI January 2010.

37） ETBE - Ethyl tertiary butyl ether. ETBE is an additive to gasoline, made of isobutene and bioethanol.

38） Woody biomass resources and conversion in Japan: The current situation and projects to 2010 and 2050. Takuyuki Yoshioka, Satoshi Hirata, Yukihiko Matsumura, Kinya Sakanishi. Biomass and Bioenergy 29 (2005) 336-346.

39） In accordance with Law on Electric Power Industry (1997) biomass is defined as products that are fully or in part are composed of plants that could be used as fuel to convert energy they contain. With such a definition, let us say dung or animal wastes do not belong to the concept of biomass. Because of this discrepancy in definitions “Ukrainian Diary Company” was producing electricity “not from biomass” as was waiting for changes in legislation or for interpretation of term “biomass” within more than 6 months.

40） Hard fuel boilers in Ukraine: sales and prospects 19-04-2010 http://www.fuelalternative.com.ua/content/nview/ru/id,31743/ (in ukr.).

41） R. Yakel Woody biofuels: status change. # 12 (792) 27.03— 2.04.2010. Weekly mirror. http://www.zn.ua/2000/2675/68949/ (in ukr.).

42） Masayoshi Saito. Further promotion of biofuel production and consumption in Japan. June 2009.

43） Kyoto Protocol Target Achievement Plan www.env.go.jp/en/earth/cc/kptap.pdf.

44） (New National Energy Strategy (Digest) issued by METI in 2006 http://www.enecho.meti.go.jp/english/data/newnationalenergystrategy2006.pdf; Ken Koyama Japan's New National Energy Strategy 2006).

45） Japan Country Report. APEC BIOFUELS TASK FORCE 7-9 October 2008.

46） Japan Country Report. APEC BIOFUELS TASK FORCE 7-9 October 2008.
47） Japan Country Report. APEC BIOFUELS TASK FORCE 7-9 October 2008.
48） Japan Country Report. APEC BIOFUELS TASK FORCE 7-9 October 2008.
49） Japan Country Report. APEC BIOFUELS TASK FORCE 7-9 October 2008.
50） Order of Cabinet of Ministers of Ukraine #145- p from 15 March 2006 "On approval of Energy Strategy of Ukraine till 2030".
51） Law on electric energy #575-97/VR, adopted on 16 October 1997, and amended on 17 November 2009.
52） Biomass – phytogenic products, used for production of electricity, heat, liquid biofuels due to transformation of energy they contain.
53） Andrew DeWit Regime Change Short-Circuited: Carbon Emissions and Japan's Feed-in Tariff System. http://www.japanfocus.org/-Andrew-DeWit/3249.
54） Shigeru Sato, Michio Nakayama Japan Proposes Wind, Geothermal Power Feed-in Tariff (Update1) March 23, 2010 http://preview.bloomberg.com/apps/news?pid=newsarchive&sid=aI3OUlVjpnm4.
55） Lee Chung Lau, Koktat Tan, Keat Teong Lee, Abdul Rahman Mohamed. Energy Policy 37 (2009) 4771-4778.

References

［1］The Japanese energy sector: Current situation, and future paths. Energy Policy (2010). Article in Press. Takase Kae, Tatsujiro Suzuki.
［2］Japan Bio-Fuels Production Report. 2006. www.fas.usda.gov/gainfiles/200605/146197881.pdf.
［3］Current situation and prospect of biomass utilization in Japan. Yukihito Matsamura, Shin-ya Yokoyama. Biomass and Bioenergy 29 (2005) 304-309.
［4］Woody biomass supply potential for thermal power plants in Japan. Tsuguki Kinoshita, Takashi Ohki, Yoshiki Yamagata. Applied Energy Vol.89, Issue 9 (2009) 2923-2927 (in print).
［5］Biomass resources present in Japan – annual quantities grown, unused and wasted. Eiji Minami, Shiro Saka. Biomass and Bioenergy. 29 (2005) 310-320.
［6］Woody biomass resources and conversion in Japan: The current situation and projects to 2010 and 2050. Takuyuki Yoshioka, Satoshi Hirata, Yukihiko Matsumura, Kinya Sakanishi. Biomass and Bioenergy 29 (2005) 336-346.
［7］Lee Chung Lau, Koktat Tan, Keat Teong Lee, Abdul Rahman Mohamed. Energy Policy 37 (2009) 4771-4778.
［8］Biofuel initiatives in Japan: Strategies, policies, and future potential. Naoko Matsumoto, Daisuke Sano, Mark Elder. Applied Energy 86 (2009) S69-S76.
［9］V. Ya. Mesel-Veselyak. Efficiency of energy self-sufficiency of agriculture. - 2009. Economics of Agriculture. - №. 2. - P.10-14 (in ukr.).
［10］Energy potential of forest residues in Ukraine http://www.ive.org.ua/atlas_04.htm (in ukr.)
［11］State Committee of Forestry of Ukraine has suggested developing a program on biofuels use 20-01-2009 http://www.fuelalternative.com.ua/content/nview/ru/id,25766/pn,3/ (in ukr.).
［12］Zabarnyy G., Kudrya S., Kondratyuk A., Chetverin G.. Thermodynamic efficiency and resources of liquid biofuels of Ukraine. –Kiev: Institute of renewable energy, UAS, 2006. – 226 p. (in ukr.).
［13］M. Pugovytsya Window to Asia was made. What for a native country? UkrAgroPortal. # 72 (2003) http://www.ukragroportal.com/propoz/item.html?PropozRubID=3&Year=2003&NumID=&obl=&ItemID=1012&Page=0 (in ukr.).
［14］M. Pugovytsya. Not only with rapeseed… Government courier. – 27.11.2007. – #222. – p.7 (in ukr.).

[15] D.B.Rakhmetov. New introduced species in fitoenergy sector of Ukraine. National botanic garden named after N.N.Gryshko (in ukr.).
[16] L.Futerko Use of woody biomass as an alternative source of energy. Ecology systems, #5, 2006. http://www.esco-ecosys.narod.ru/2006_5/art31.htm (in ukr.).
[17] Biomass action plan for Ukraine. 2009. – Kyiv. – 44 p. Ministry of agricultural policy and Agency Senter Novem of Ministry of economics of the Netherlands. (in ukr.).
[18] IEA, *Ukraine Energy Policy Review*, 2006, pp. 75-77.
[19] Hisao Fukuda, Aaron Kingsbury, Kakayu Obara. Japan. Bio-Fuels production report. 26 May 2006.
[20] Biomass resources present in Japan – annual quantities grown, unused and wasted. Eiji Minami, Shiro Saka. Biomass and Bioenergy 29 (2005) 310-320.
[21] Japan Country Report. APEC BIOFUELS TASK FORCE 7-9 October 2008 www.biofuels.apec.org/pdfs/apec_200810_ikeda.pdf.
[22] S.Kalenska, D.Rakhmetov Justification of alternative sources of plant material for biofuel production. National Agrarian University, National botanic garden named after N.N. Gryshko. 2008. (in ukr.).
[23] State of art and prospects of biogas production in Ukraine. Ministry of agricultural policy. 2009 http://www.minagro.kiev.ua/page/?n=7793 (in ukr.).
[24] World Energy Outlook 2009, p.74.
[25] Europe's Energy Portal http://www.energy.eu/.
[26] Andrew DeWit Regime Change Short-Circuited: Carbon Emissions and Japan's Feed-in Tariff System. http://www.japanfocus.org/-Andrew-DeWit/3249.
[27] Key World Energy Statistics. – Paris: International Energy Agency, 2008. – 80 pp.
[28] State Committee of Statistics of Ukraine.
[29] Biomass Nippon.
[30] Pilot plant starts producing bioethanol from soft cellulose biomass 26 March 2010 http://www.japanfs.org/en/pages/029805.html.
[31] Joint Research to Develop Cellulose Bio-Ethanol by 2015. 6 May 2009 http://www.japanfs.org/en/pages/028959.html.
[32] National Policies on Automotive Biofuels in Japan. Fukumi NISHIMAKI January 2010 https://www.pecj.or.jp/japanese/overseas/conference/pdf/2.pdf.
[33] Masayoshi Saito. Further promotion of biofuel production and consumption in Japan. June 2009.
[34] FAPRI 2010 Agricultural Outlook.
[35] International Energy Agency www.iea.org.
[36] Toepfer International. www.acti.de.
[37] Digest «Renewable energy of Ukraine», JSC «FuelAlternative», 2010, pp. 36,37 (in ukr.).
[38] Amounts of sunflower husk pellets and briquettes export in 2009, prospects for 2010. 14-05-2010 http://www.fuelalternative.com.ua/content/analytic_view/ru/id,31908/ (in ukr.).
[39] Hard fuel boilers in Ukraine: sales and prospects 19-04-2010 http://www.fuelalternative.com.ua/content/nview/ru/id,31743/ (in ukr.).
[40] R. Yakel Woody biofuels: status change. # 12 (792) 27.03 — 2 April 2010. Weekly mirror. http://www.zn.ua/2000/2675/68949/ (in ukr.).
[41] Masayoshi Saito. Further promotion of biofuel production and consumption in Japan. June 2009.
[42] What is RPS system in Japan? www.rps.go.jp/RPS/new-contents/english/inEnglish.html.
[43] Kyoto Protocol Target Achievement Plan www.env.go.jp/en/earth/cc/kptap.pdf.
[44] New National Energy Strategy (Digest) issued by METI in 2006 http://www.enecho.meti.go.jp/english/data/newnationalenergystrategy2006.pdf.
[45] Ken Koyama Japan's New National Energy Strategy 2006 www.gas.or.jp/english/letter/images/05/pdf/

newstrategy.pdf.
[46] State Program"Production of diesel biofuel".
[47] Order of Cabinet of Ministers of Ukraine #145- p from 15 March 2006 "On approval of Energy Strategy of Ukraine till 2030".
[48] Law on electric energy #575-97/VR, adopted on 16 October 1997, and amended on 17 November 2009.
[49] Shigeru Sato, Michio Nakayama Japan Proposes Wind, Geothermal Power Feed-in Tariff (Update1) March 23, 2010 http://preview.bloomberg.com/apps/news?pid=newsarchive&sid=aI3OUlVjpnm4.
[50] Masaru Kagatsume, "Canola Project as the Rural Resource Recycling and Regional Revitalization", in Research Book (ed by Souki, "Economic Development and Environmental Protection in Northern Area China"), Inner Mongolia Science and Technology Press, pp.321-345, July, 2009.

（受理日　2012 年 1 月 12 日）